

A portable robotic vacuum cleaner (10) has a handle (100) provided on one side adjacent a driving wheel (14). The handle (100) is spring-biased into the upwardly projecting position shown for lifting the cleaner (10) off the floor. The handle lies substantially within the envelope of the cleaner (10) and is shaped so that it can be readily grasped by a user (101). As the user (101) lifts the cleaner (10) the handle (100) pivots away from the side of the cleaner (10), the cleaner (10) turns clockwise, and the handle (100) projects outwardly from the side of the cleaner (10) when the cleaner (10) has been lifted off the floor and is being carried. The handle (100) considerably

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### Portable Appliance

This invention relates to a portable appliance and particularly, but not exclusively, to a small domestic or industrial robotic cleaning appliance.

There has long been a desire for a vacuum cleaner which is capable of cleaning a room without the need for a human user to push or drag the cleaner around the room, and a number of robotic or autonomous vacuum cleaners have been proposed. A self-guiding vacuum cleaner is known from EP 0 803 224 A. This self-guiding vacuum cleaner includes a chassis which supports a housing with a cover and a front part which is moveable with respect to the chassis. The front part is integrated with an obstacle sensing system. The cover is secured to the housing and the housing continues immediately behind the front part into an intermediate wall. The intermediate wall continues into a handle by means of which the vacuum cleaner is carried. The chassis supports a brush nozzle and roll, a fan unit, a dust container, rechargeable batteries, a drive motor for driving each of the two wheels, and another motor for driving the brush roll. The cleaner has an electric system provided with electronic circuits and electric components necessary to guide and control movement of the vacuum cleaner on the floor. Such a vacuum cleaner is quite heavy due to the weight of the on-board batteries, four electric motors and the other various parts. This can make it potentially inconvenient for the user, for example, when carrying it up and down a flight of stairs and lifting it on and off the floor to be cleaned.

The present invention seeks to improve the portability of a portable appliance such as a robotic vacuum cleaner.

An aspect of the present invention provides a portable appliance comprising a handle which is moveable on the appliance between a first operative position in which it can be gripped by a user to lift the appliance from the floor, and a second operative position different from the first in which it can be gripped by the user to carry the appliance.

Preferably, the handle is located on a side of the appliance. This is particularly advantageous where the appliance has dimensions in which the diameter of the appliance is greater than the height of the appliance. By providing the handle on the side, a user can use the handle to firstly lift the appliance on to its side and then to carry the appliance in a position in which the base of the appliance is positioned vertically. In the first operative position the handle is substantially parallel with the side of the appliance and in the second operative position it is substantially perpendicular to the side of the appliance.

Preferably the handle remains in the first position during normal use of the appliance. This can be achieved by spring-biasing the handle into the first position.

Preferably, in the first operative position, the part of the handle which a user is intended to grasp is supported in a position in which it is sufficiently spaced from the body of the appliance so that it can be grasped by a user.

Preferably, in the first position, the handle lies substantially within the envelope of the cleaner. That is to say, the handle does not protrude beyond the dimensions of the appliance established by other parts of the appliance.

The above is particularly advantageous where the appliance is a vacuum cleaner.

Preferably the appliance has wheels for supporting it on a floor, drive means for driving the appliance across the floor, a front, a back, a top, and two opposite sides (all in relation to the direction of forwards driving) and the handle is located on one side and provides a circumferentially extending side region of the appliance.

Preferably the appliance comprises a vacuum cleaner having a chassis, supporting wheels mounted on the chassis, drive means connected to the supporting wheels for

driving the supporting wheels, a control mechanism for controlling the drive means so as to guide the vacuum cleaner across a surface to be cleaned, a cleaner head having a dirty air inlet facing the surface to be cleaned, and separating apparatus supported by the chassis and communicating with the cleaner head for separating dirt and dust from an airflow entering the vacuum cleaner by way of the dirty air inlet.

Preferably the separating apparatus is cyclonic and the handle pivots the separating apparatus about an axis which is parallel to the cyclone axis.

Preferably the separating apparatus comprises two cyclones, the upstream cyclone being adapted to remove comparatively large dirt and dust particles from the airflow and the downstream cyclone being adapted to remove comparatively small dirt and dust particles from the airflow. It is also preferred if the cyclones are arranged concentrically, more preferably one inside the other, so as to provide a compact and convenient arrangement. In this case the outer low efficiency cyclone can be generally cylindrical in shape and the inner high efficiency cyclone can be frusto-conical in shape.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, wherein:-

Figure 1 is a perspective view of a vacuum cleaner according to the embodiment of the invention;

Figure 2 is a plan view of the vacuum cleaner of Figure 1;

Figure 3 is a rear view of the vacuum cleaner of Figure 1;

Figure 4 is a side view of the vacuum cleaner of Figure 1;

Figure 5 is a second rear view (on a smaller scale) of the vacuum cleaner of Figure 1 during lifting;

Figure 6 is a third rear view (on a smaller scale) of the vacuum cleaner of Figure 1 while being carried;

Figure 7 is a perspective view of the handle and associated parts and features of the embodiment of the invention; and

Figure 7a is a local section just in the region of one of the axles 103 in Figure 3 and on a much enlarged scale.

The vacuum cleaner 10 shown in the drawings has a supporting chassis 12 which is generally circular in shape and is supported on two driven wheels 14,14' and a castor wheel 16. The chassis 12 is preferably manufactured from high strength moulded plastics material, such as ABS, but can equally be made from metal such as aluminium or steel. The chassis 12 provides support for the components of the cleaner 10 which will be described below. The driven wheels 14,14' are arranged at either end of the diameter of the chassis 12, the diameter line perpendicular to the longitudinal axis 18 of the cleaner 10. Each driven wheel is moulded from high strength plastics material and carries a comparatively soft, ridged band around its circumference to enhance the grip of the wheel when the cleaner 10 is traversing a smooth floor. The driven wheels 14,14' are mounted independently of one another via support bearings and each driven wheel is connected directly to a respective motor (not shown) which is capable of driving the respective wheel in either a forward direction or a reverse direction. By driving both wheels 14,14' forward at the same speed, the cleaner 10 can be driven in a forward direction. By driving both wheels in a reverse direction at the same speed, the cleaner can be driven in a backward direction. By driving the wheels 14,14' in opposite directions, the cleaner can be made to rotate about its own central axis so as to effect a

turning manoeuvre. The aforementioned method of driving the vehicle is well known and will not therefore be described any further here.

The castor wheel 16 is not driven and merely serves to support the chassis 12 at the rear of the cleaner 10. The castor wheel 16 is swivellingly mounted on the chassis by means of a swivel joint 20.

Mounted on the underside of the chassis 12 is a cleaner head 22 which includes a suction opening (not shown) facing the surface on which the cleaner 10 is supported. A brush bar (not shown) is rotatably mounted in the suction opening and a motor (not shown) is mounted on the cleaner head 22 for driving the brush bar by way of a drive belt (not shown).

As can be seen from Figures 1 and 2, the cleaner head 22 is asymmetrically mounted on the chassis 12 so that one side of the cleaner head 22 protrudes beyond the general circumference of the chassis 12. This allows the cleaner to clean up to the edge of a room on the side of the cleaner shown in Figure 1 on which the head 22 protrudes.

The chassis 12 carries a plurality of sensors 40 which are designed and arranged to detect obstacles in the path of the cleaner 10 and its proximity to, for example, a wall or other boundary such as a piece of furniture. The sensors 40 comprise several ultrasonic sensors and several infrared sensors, sufficient to enable the cleaner 10 to guide itself or to be guided around a predefined area so that the area can be cleaned. Control software, comprising navigation controls and steering devices, is housed within a housing 42 located beneath a control panel 44 or elsewhere within the cleaner 10. Battery packs 46 are mounted on the chassis 12 inwardly of the driven wheels 14,14' to provide power to the motors for driving the wheels and to the control software. The battery packs 46 are removable to allow them to be transferred to a battery charger (not shown).

The vacuum cleaner 10 also includes a motor and fan unit (not shown) supported on the chassis 12 within housing 42 for drawing dirty air into the vacuum cleaner 10 via the suction opening in the cleaner head 22. The chassis 12 also carries a cyclonic separator 52 for separating dirt and dust from the air drawn into the cleaner 10. The cyclonic separator 52 comprises inner and outer cyclones arranged concentrically and both cyclones have their coaxial axes lying horizontally in normal use of the cleaner on a floor.

The visible part of the separator 52 is made from a transparent plastics material to allow a user to view the interior of the outer cyclone. Located on the separator 52 are opposed gripper portions 70 which are adapted to assist the user to remove the separator 52 from the chassis 12 for emptying purposes.

The vacuum cleaner 10 described above operates in the following manner. In order for the cleaner to traverse the area to be cleaned, the wheels 14,14' are driven by their respective motors which, in turn, are powered by the batteries 46. The direction of movement of the cleaner is determined by the control software which communicates with the sensors 40 which are designed to detect any obstacles in the path of the cleaner so as to navigate the cleaner 10 around the area to be cleaned. Methodologies and control systems for navigating a robotic vacuum cleaner around a room or other area are well documented elsewhere and do not form part of the inventive concept of this invention.

The batteries 46 also provide power to operate the motor and fan unit to draw air into the cleaner. The brush bar motor is also driven by the batteries. The dirty air is drawn into the cleaner head 22 and conducted to the cyclonic separator 52 where dirt and larger fluff particles are separated by the outer cyclone and fine dirt and dust is separated in the inner cyclone. The cleaned air exits the cyclonic separator and is passed over or around the motor and fan unit in order to cool the motor before it is expelled into the atmosphere.



Each battery pack 46 has a handle 46A by which it can be pulled forwards from and inserted rearwards into a respective recess 42C in the housing 42. The forwards and rearwards directions are indicated by double headed arrows 46B in Figure 1. When it needs to be recharged it is removed from the cleaner and when it has been recharged it is replaced in the cleaner so the cleaner is ready for use. As shown in the drawings the battery packs 46 are held in position on the chassis in their respective recesses so that the packs are not permitted to move during normal use of the vacuum cleaner. Each battery pack 46 has an electrical connection (not shown) and each recess 42C has a connector point (not shown). The arrangement is such that the battery pack connection and the connector point in the recess are automatically brought into alignment and electrical contact when the battery pack is fully inserted in the recess 42C.

The vacuum cleaner weighs about 9 kilograms in this embodiment. In other embodiments the weight could be between 5 and 15 kilograms. The centre of gravity cg lies on or close to the longitudinal axis 18 and slightly behind the rotational axes of wheels 14,14'.

In order to lift the cleaner on to and off the floor and to carry it from one area to another, it has a handle 100 adjacent wheel 14 at one side of the cleaner as visible in Figure 1. The handle 100 has a first operative position for lifting the cleaner off the floor shown in Figures 1 to 4, and a second operative position shown in Figure 6 for carrying the cleaner. The handle moves between the first and second positions during lifting and lowering as shown in Figure 5.

In Figure 3 the cleaner is resting on a level floor. The handle 100 is spring-biased into its first operative position and the user grabs the handle with his hand 101 to lift the cleaner. As the user lifts the cleaner off the floor the handle moves away from the cleaner as the cleaner rotates clockwise and the cleaner is partly supported by the floor under wheel 14' and partly by the user through the handle, as shown in Figure 5.

As the user continues to lift by the handle, the cleaner rotates further clockwise until wheel 14' is clear of the ground and the handle adopts its second operative position projecting outwardly from the side of the cleaner (Figure 6). The user can then comfortably carry the cleaner 10 to another area. In addition to carrying the cleaner to another area, a user may fully or partially rotate the cleaner 10 on to its side, with wheel 14' resting on the floor to expose the lower face of the cleaner 10. This allows the user to access the lower face of the cleaner 10 to clear an obstruction to one of the wheels or to the brush bar within cleaner head 22.

The handle is generally U-shaped (Figure 7) and moulded from plastics material such as a polycarbonate-ABS mix. It has a journal 102 at each end of the U arms 100B and is pivotally mounted (axis X...X in Figure 4 and also indicated X in Figure 3) in recesses 104 (Figure 7a) in the housing part 42A by means of axles 103 which are trapped in grooves 105 in the lower part 42A of the housing. The upper housing part 42 has corresponding tongues 104 which enter the grooves 105 when the parts 42,42A are assembled during manufacture of the cleaner, and hold the axles 103 at the bottoms of the grooves 105.

Each journal 102 has a coiled spring 106 which is coiled around the respective axle 103 and biases the handle in its first operative position. Each spring end 106A engages the lower housing part 42A, as shown in Figure 4, and exerts a rotational force by its other end 106B on the handle 100 and biases the U arms 100B against a cooperating surface 42C of the upper housing part 42 (Figures 2 and 3).

The underside 100A of the handle 100 is an over moulded softer piece which enhances the grip and comfort of the handle for the user.

As can be seen in Figure 2, the handle is curved in plan view of the cleaner providing a gap 200 between the handle 100 and the side of battery pack 46 sufficient for a user to

insert their hand 101 to grab the handle while the handle is in the first operative position. Figure 4 shows a side view of the cleaner, showing how the handle 100 is also spaced from the circumference of wheel 14 by the region 202 which is sufficient to allow a user to insert their hand under the handle 100. Thus, a user can firmly place their hand fully around the handle 100 without first having to displace the handle from a storage position. In a plan view, as shown in Figure 2, the handle has a circumferential shape the same as, or very similar to, the circumferential shape of the cleaner. In the plan view the handle lies within the envelope of the cleaner, i.e. it does not protrude beyond the outermost shape of the cleaner. This helps maintain a substantially circular shape for the cleaner so that it is less likely to touch or even damage vulnerable upright surfaces of furniture or walls of the area being cleaned. The vertical profile of the handle is also such that the uppermost part 204 of the handle 100 lies below the uppermost extent of the cleaner so that it does not present an obstruction which could catch on an object that the cleaner passes beneath.

In the present embodiment when the cleaner is lifted, the cleaner rotates only around an axis parallel to the longitudinal axis 18 of the cyclonic separating apparatus thereby minimizing any disturbance to the dust and dirt contained within the separating apparatus.

Also the handle 100 is located on one side of the cleaner and the direction of removal and replacement 42B of the battery packs is transverse to the gravitational force on the packs during lifting and carrying the cleaner. Thus the force of the gravity will not tend to dislodge the batteries from the cleaner during lifting and carrying the cleaner by the handle 100.

**Claims**

1. A portable appliance comprising a handle which is moveable on the appliance between a first operative position in which it can be gripped by a user to lift the appliance from the floor, and a second operative position different from the first in which it can be gripped by the user to carry the appliance.
2. An appliance according to claim 1 wherein the handle is located on a side of the appliance.
3. An appliance according to claim 2 wherein, in the first operative position the handle is substantially parallel with the side of the appliance and in the second operative position it is substantially perpendicular to the side of the appliance.
4. An appliance according to any one of the preceding claims wherein the handle remains in the first position in use of the appliance.
5. An appliance according to claim 4, wherein the handle is spring-biased into the first position.
6. An appliance according to any one of the preceding claims wherein, in the first operative position, the part of the handle which a user is intended to grasp is supported in a position in which it is sufficiently spaced from the body of the appliance so that it can be grasped by a user.
7. An appliance according to claim 6 wherein the handle provides a circumferentially extending side region of the appliance.
8. An appliance according to any one of the preceding claims wherein, in the first position, the handle lies substantially within the envelope of the cleaner.

9. An appliance according to any one of the preceding claims wherein the appliance is a vacuum cleaner.

10. An appliance according to claim 9 wherein the vacuum cleaner comprises a separating apparatus and the handle is located so that, in use, the handle pivots the vacuum cleaner about an axis which is parallel to the longitudinal axis of the separating apparatus.

11. An appliance according to claim 10 wherein the separating apparatus is a cyclonic separating apparatus comprising at least one cyclone chamber, and the handle is located so that, in use, the handle pivots the vacuum cleaner about an axis which is parallel to the longitudinal axis of the cyclone chamber.

12. An appliance according to any one of claims 9 to 11 comprising battery packs for powering the appliance, the battery packs being removable from the chassis of the appliance in a direction which is transverse to the direction of gravitational forces acting on the packs during use of the handle.

13. An appliance according to any one of claims 9 to 12 in the form of a robotic portable vacuum cleaner

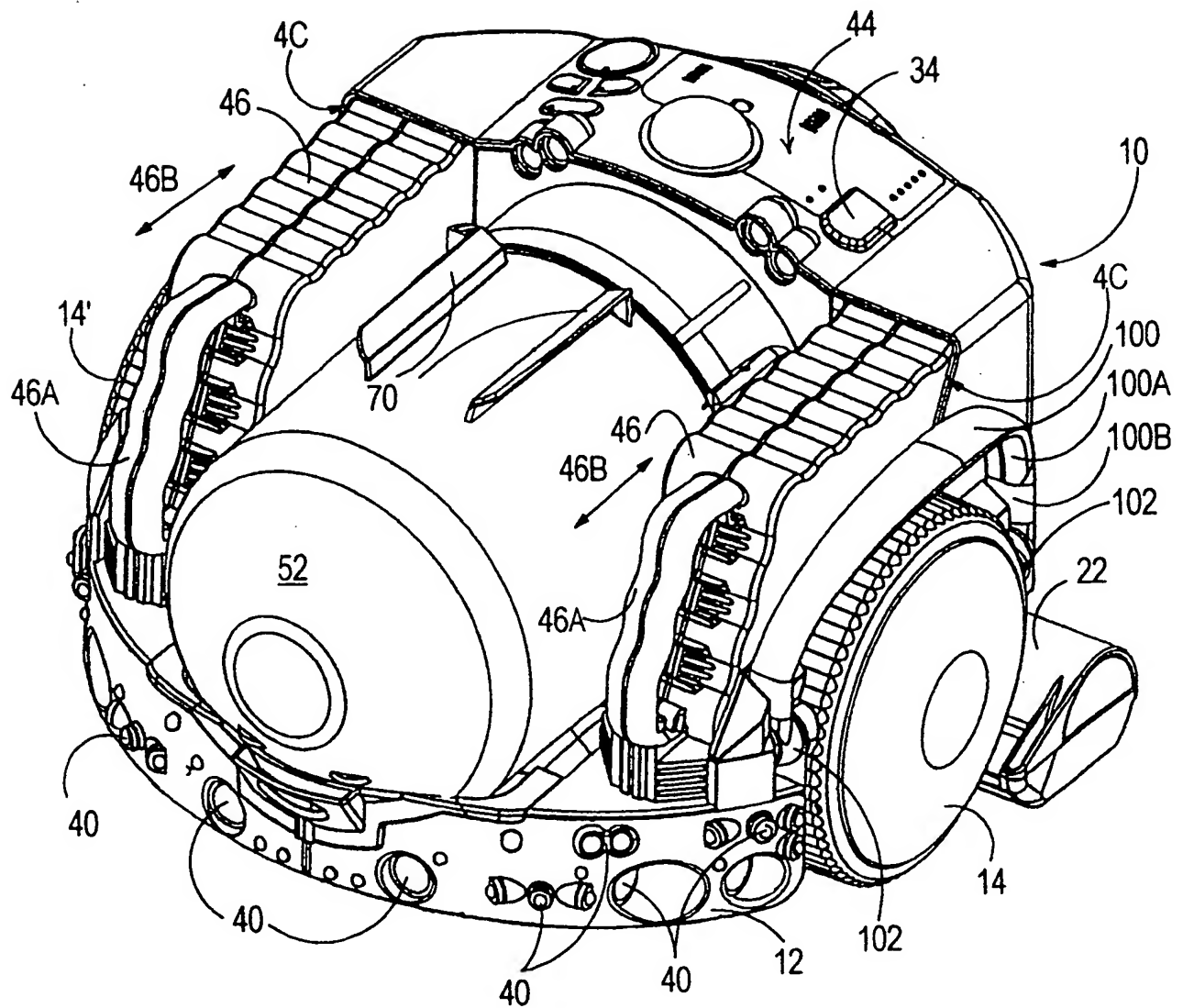
14. An appliance according to claim 13 comprising a driving wheel on each side and wherein the handle is located adjacent one of the wheels.

15. An appliance according to claim 14 wherein the handle is arc-shaped and is located so that, in the first operative position, it lies around the circumference of the wheel.

16. An appliance according to any one of claims 13 to 15 comprising a cleaner head protruding from one side of the cleaner, and wherein the handle is located on said one side of the cleaner.

17. An appliance substantially as described herein with reference to the accompanying drawings.

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**FIG.1.**

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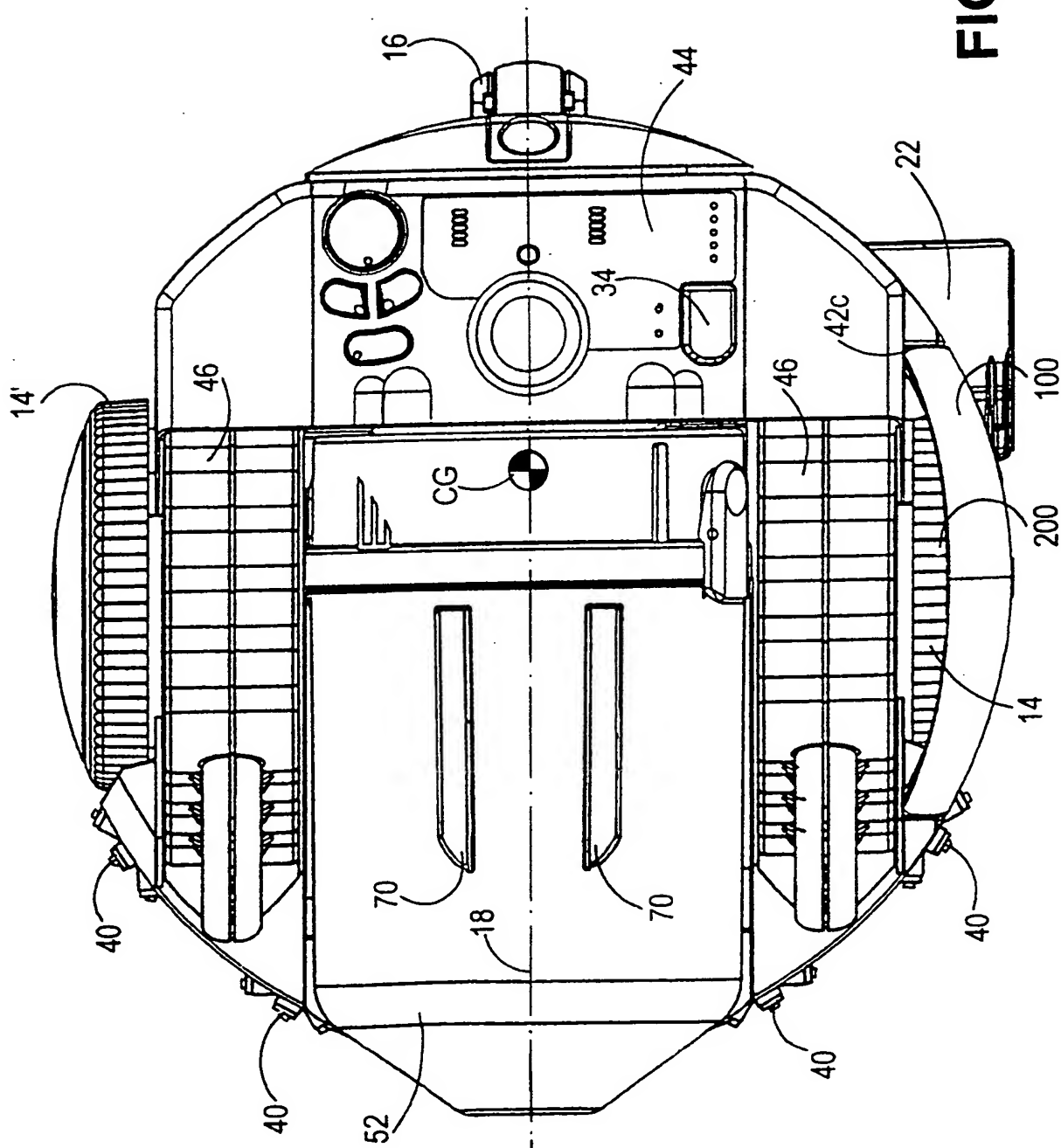


FIG. 2.



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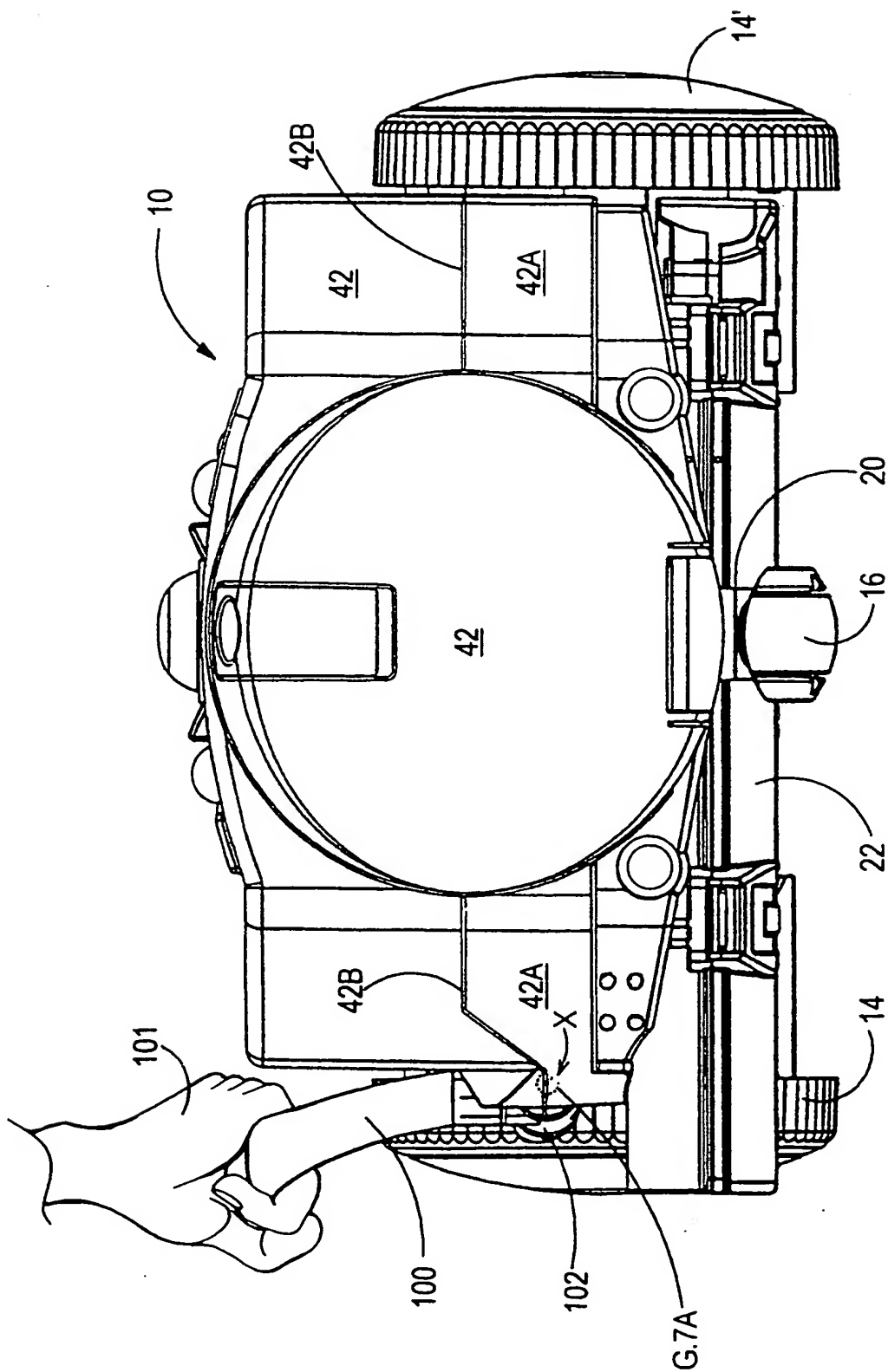
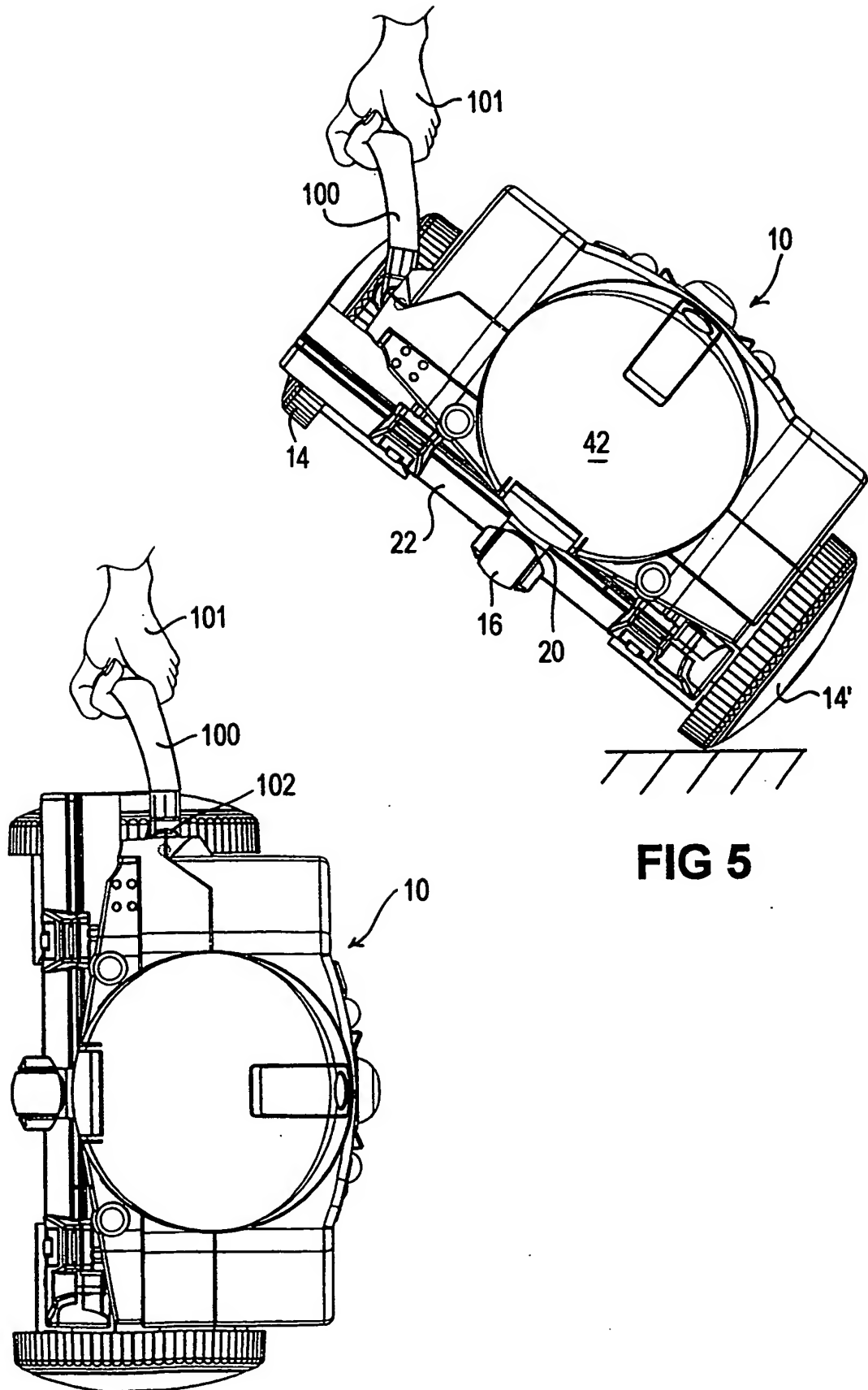


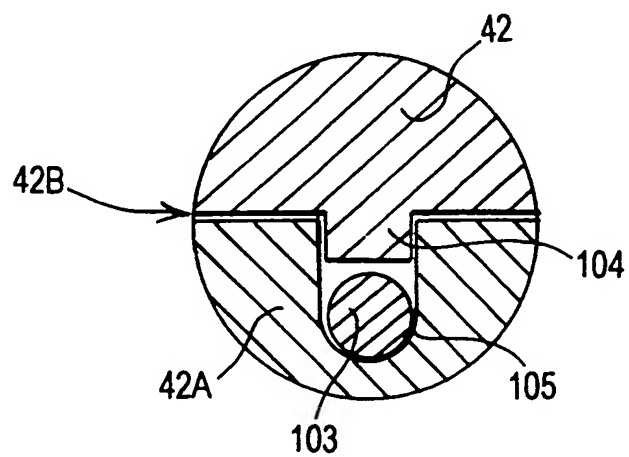
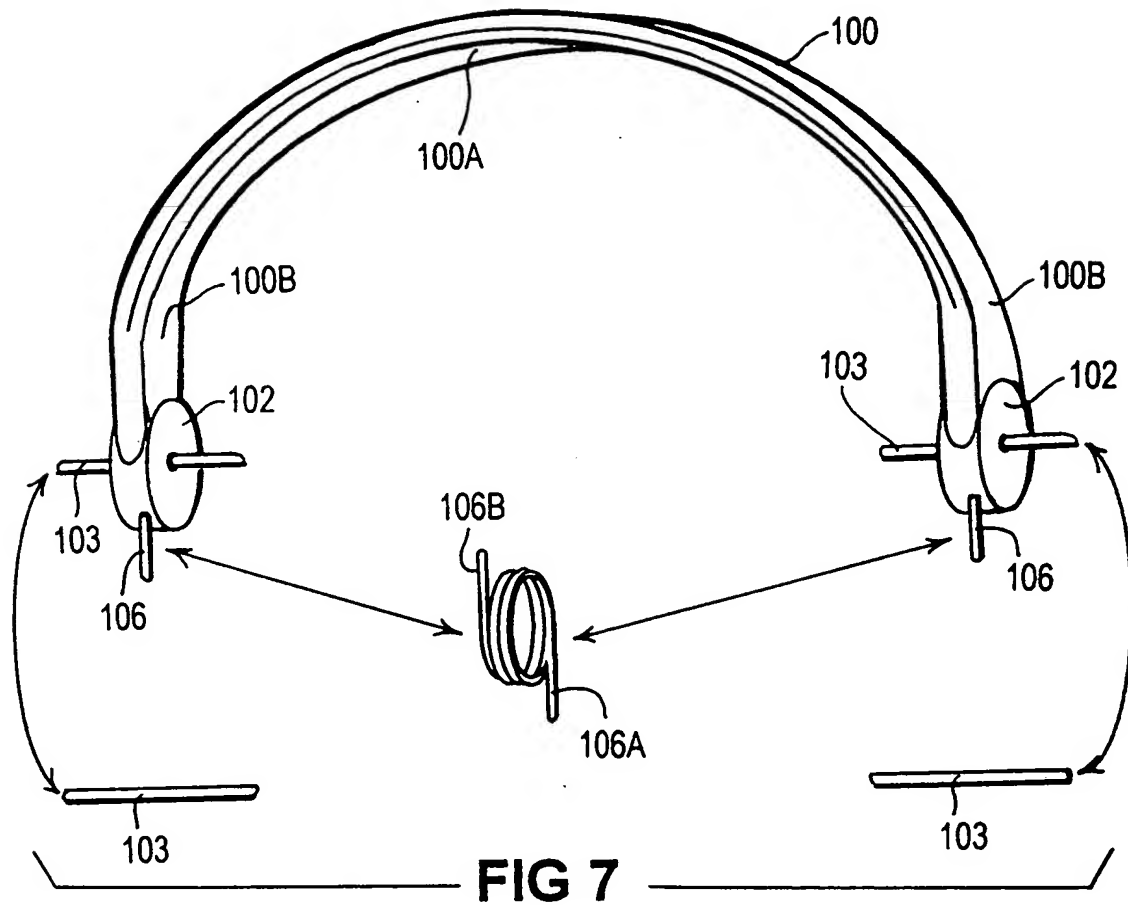
FIG. 3.



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## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/04258

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 A47L9/32

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A47L B65D A45C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	EP 0 935 944 A (ELECTROLUX AB) 18 August 1999 (1999-08-18) abstract column 3, line 50 - column 4, line 12 figures 1-3	1,4,6,7, 9
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A	EP 0 362 895 A (HITACHI LTD) 11 April 1990 (1990-04-11) abstract column 10, line 5 - line 30 claim 23; figures 2,9,10	1,3,4,8, 9
	— -/-	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	<p>PATENT ABSTRACTS OF JAPAN vol. 016, no. 533 (C-1002), 4 November 1992 (1992-11-04) - &amp; JP 04 200428 A (HITACHI LTD), 21 July 1992 (1992-07-21) abstract; figures</p>	1,3,4,8, 9
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A	<p>EP 0 654 414 A (HARDIGG IND INC) 24 May 1995 (1995-05-24) column 2, line 58 - column 3, line 12 column 4, line 25 - line 37 figures 1,4-6</p>	5
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